for reference.

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High quality GaN film on low-temperature AlGaN buffer layer grown with high growth rate

Sanyo Electric Co., Ltd.
Microelectronics Research Center
Takashi Kano, Hiroki Ohbo, Masayuki Hata,
Tatsuya Kunisato, Tsutomu Yamaguchi, Takenori Goto,
Nobuhiko Hayashi, Masayuki Shono, Minoru Sawada
E-Mail: t-kano@rd.sanyo.co.jp

1. Introduction A GaN layer on sapphire is generally grown on a buffer layer grown at a low temperature, and it is important to optimize conditions of the buffer layer and the GaN layer grown thereon for improving the characteristics of a nitride-based light-emitting device. This time we have found out that a high-quality GaN film can be obtained by remarkably increasing the growth rate for a buffer layer, and report this.

2. Experiment GaN was grown on c-~~plane~~ face sapphire by atmospheric pressure MOCVD in a two-step growth method. A buffer layer was prepared from AlGaN, and growth temperatures for the buffer layer and the GaN layer grown thereon were 600°C and 1080°C respectively. The growth rate for the buffer layer

Growth Conditions

1. Structure of MOCVD Apparatus

1-1. ~~Trilaminar~~ Horizontal MOCVD Apparatus
three layered flow
1-2. Heating System by High-Frequency Oscillation

2. Growth Conditions for AlGaN Low-Temperature Buffer Layer

2-1. Substrate: Sapphire ~~C-Plane~~ Substrate
C-face
2-2. Used Materials: TMAl, TMGa, NH3, H2 and N2

$TMAl/(TMAl + TMGa) \fallingdotseq 0.5$

2-3. Growth Temperature: 600°C

2-4. Thickness of Grown Film: 120 to 140 Å

3. Growth Conditions for GaN Layer

3-2. Used Materials: TMGa, NH3, H2 and N2

3-2. Growth Temperature: 1080°C

Structure of and Method of Evaluation for Evaluated Sample

Structure of Evaluated Sample

GaN Layer (4 μm)
AlGaN Low-Temperature Buffer Layer (120 to 140 Å)
Sapphire ~~C-Plane~~ Substrate

C-face

Evaluation Method

1. Full Width at Half Maximum in X-Ray Diffraction Rocking Curve

   GaN(0002) Diffraction

2. Etch Pit Density

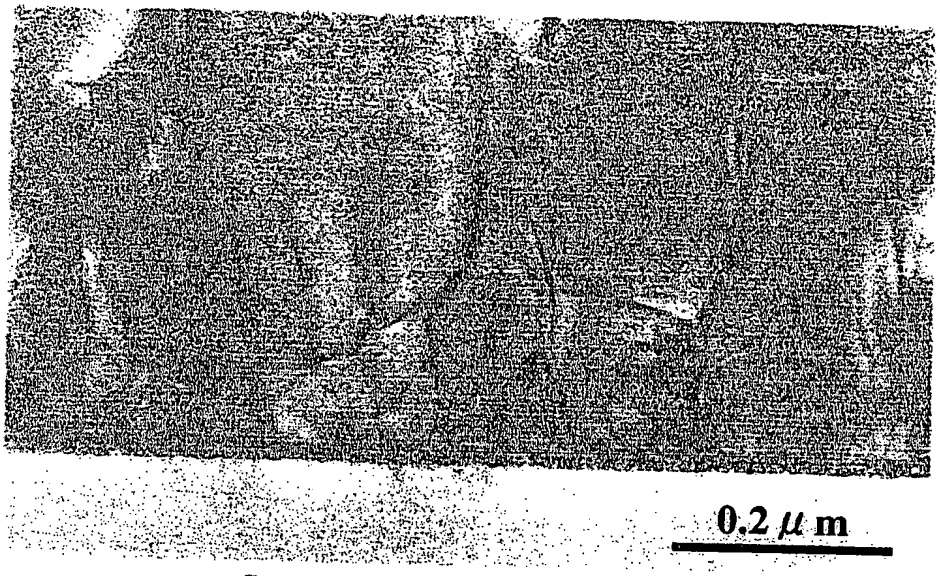
   Etching Method NaOH:KOH = 5:1 (280°C)

3. Sectional TEM Observation

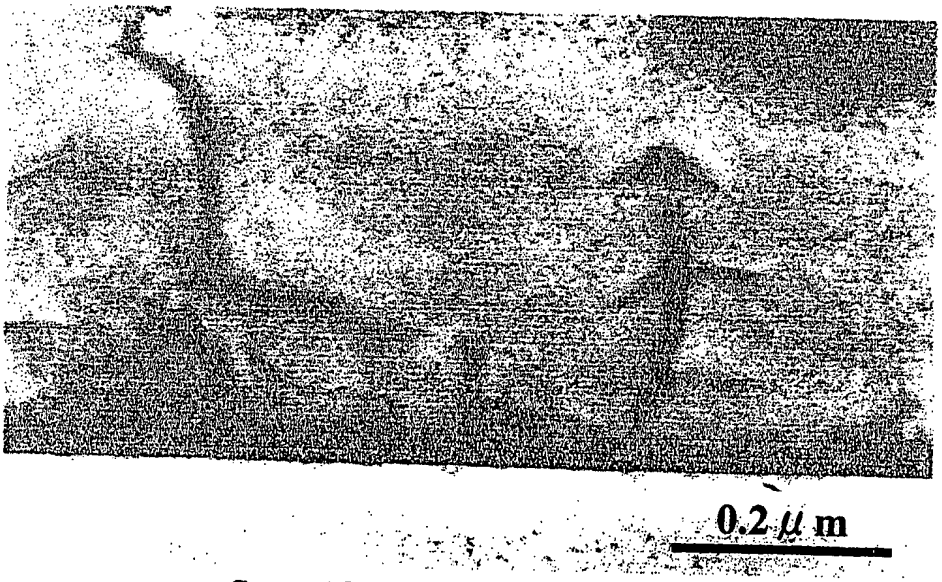
Observations of etch pits in GaN layers

(1) "~~Evaluation of Defects by Etch Pit in GaN~~ " by Masayuki Hata et. al., Sanyo Electric Co., Ltd. Microelectronics Research Center

Extended Abstracts of the 57th Meeting of the Japan Society of Applied Physics (1996), No. 1, p. 302



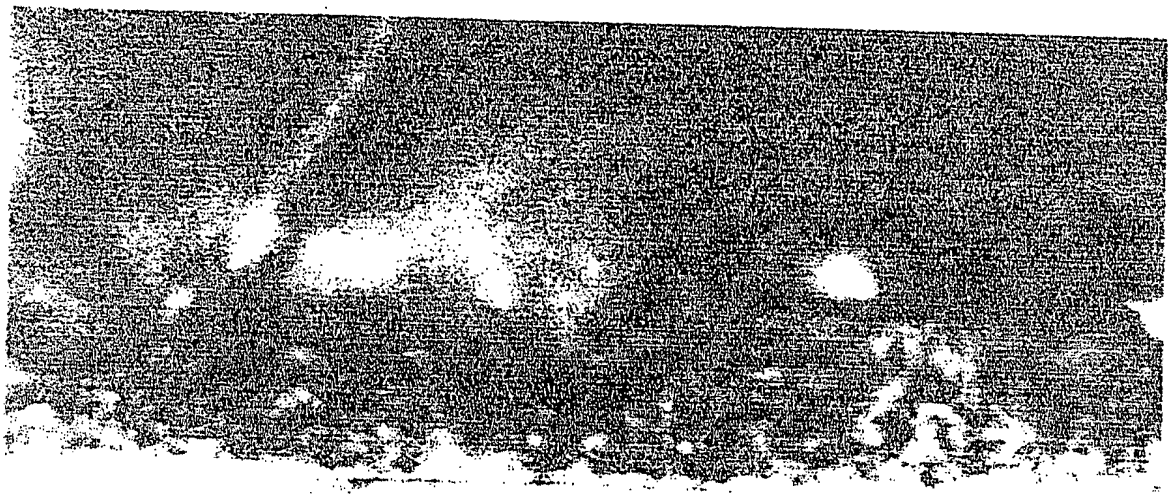
Growth Rate: 6.7 Å/sec.



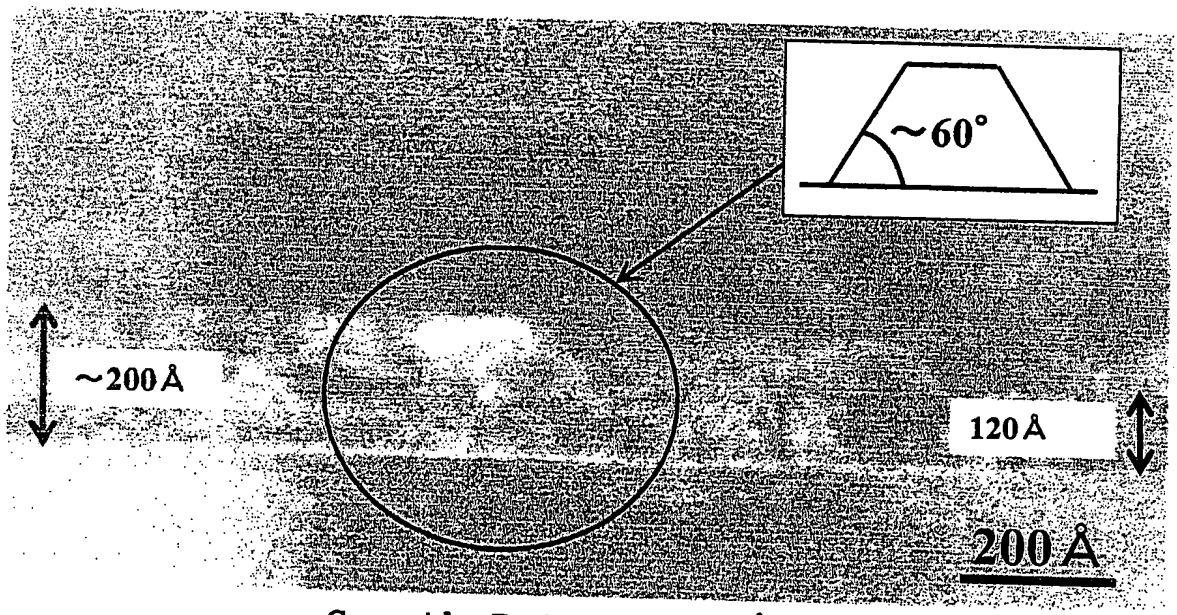
Growth Rate: 25.0 Å/sec.

Sectional TEM Photograph of Interface Between Sapphire Substrate and GaN Layer (× 300,000)

[Sectional Photograph on GaN (11-20) ~~Planel~~ face



Growth Rate: 6.7 Å/sec.



Growth Rate: 25.0 Å/sec.

- Sectional TEM Photograph of Interface Between Sapphire Substrate and GaN Layer (×2,000,000) [Sectional Photograph on GaN (11-20) ~~Plane~~ face

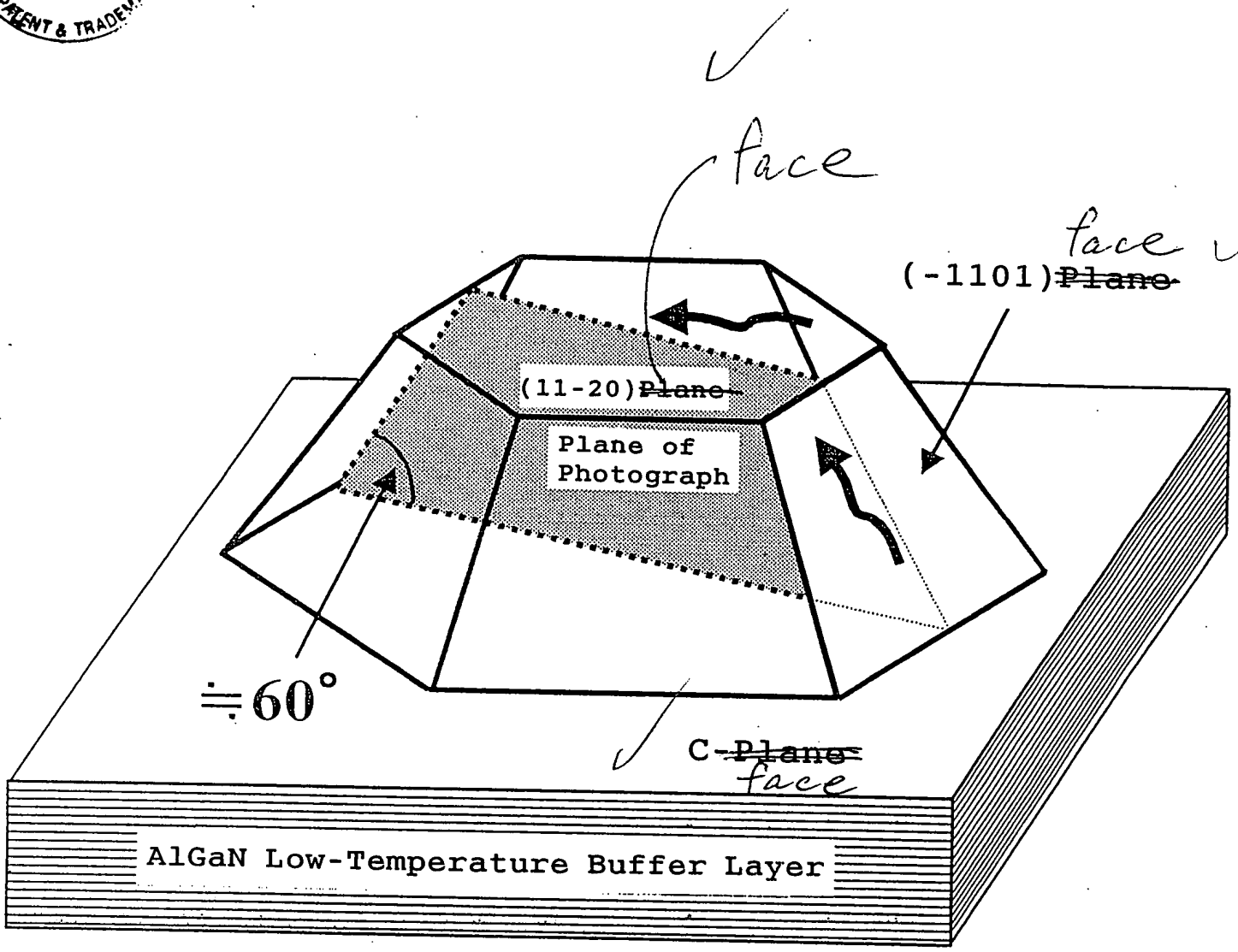


Image Diagram of Direction of Defect in Initial State of Growth of GaN Layer Employing Fast-Grown AlGaN Low-Temperature Buffer Layer

Conclusion

1. Increasing growth rate of AlGaN low-temperature buffer layer to 25 to 30 Å/sec.

GaN Layer

·Full Width at Half Maximum of X-Ray Rocking Curve: 250 sec.

·Etch Pit Density: 1.0 × [10^9 cm^{-2}]

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From sectional TEM on the interface between sapphire and GaN:

① Most of defects caused on the interface progress in directions parallel to the (-1101) ~~plane~~ face and the C-~~plane~~ face.

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② The number of through defects in the C-axis direction decreases.

2. A blue semiconductor laser of room-temperature continuous oscillation was obtained through high-quality GaN growth.